

Excellence in Writing Contest Winner

One must be aware of a significant point. During World War I, the US Army essentially built two separate and different air forces: the first, a training air force in the continental United States, the second, a combination training and combat air force in Europe. A comparison of the chaotic development of maintenance training by the Air Service in the United States with the more logical development of maintenance training by the Air Service, AEF, in France—though it was still something less than a smooth process—indicates the importance of the Royal Flying Corps/Air Service, AEF relationship to US combat capability.

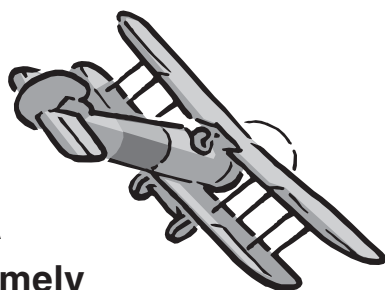
logistics history

The Tail to Tooth Ratio: Royal Flying Corps and Air Service Cooperation in Maintenance Training During World War I

As America prepared to enter World War I, one thing was clear—it was incapable of sending a modern army to fight in Europe. As a result, an American presence on the Western Front could be attained only through substantial assistance from the Allied powers. From a ground warfare perspective, preparation and training would be, for the most part, in French hands. However when it came to aviation, the story would be different. The US Army turned to the Royal Flying Corps in its preparations for combat in the air. In doing so, it began a

tradition of mutual cooperation that has endured on many fields of conflict to the present time. In the award winning “The Tail to Tooth Ratio: Royal Flying Corps and Air Service Cooperation in Maintenance Training During World War I,” Miller examines the various approaches to maintenance and specialist training and the close interaction between US and British forces. He highlights the successes and failures in developing maintenance and maintenance training programs.

the *tail* to *Tooth* Ratio



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Royal Flying Corps and Air Service Cooperation in Maintenance Training During World War I

Little need exists here to detail the size, strength, and capability of the US Army at the time the United States declared war on the Central Powers in April 1917. Simply put, in every way possible, the United States was incapable of sending a modern army to fight in Europe. A British military mission that reached Washington DC a few weeks after the declaration accurately summarized the situation in four laconic, well-chosen words: “They are quite unprepared.”¹ Seldom has the British talent for understatement been more appropriate. This situation, especially in the eyes of British and French leaders, would be complicated over the next year by the American determination to field a separate, independent army and stubborn refusal to *amalgamate* with the Allied armies.² We could spend hours discussing the controversy over amalgamation, but suffice to say that Secretary of War Newton Baker’s instructions to the commander of the American Expeditionary Force (AEF), General John J. Pershing, issued on 26 May 1917, were clear and firm: “In military operations. . . you are directed to cooperate with the forces of the other countries employed against the enemy, but in so doing, the underlying idea must be kept in view that the forces of the United States are a separate and distinct component of the combined forces, the identity of which must be preserved.”³ And, as European leaders would soon discover, probably no American general between “Mad” Anthony Wayne and “Stormin” Norman Schwartzkoff could be determined more relentlessly to follow instructions—especially those he agreed with—than “Black Jack” Pershing.⁴ Thus, the essential question was reduced to how best to organize, train, equip, and deploy an independent army, starting from almost nothing. The answer, readily apparent to all competent observers, was that a timely American presence on the Western Front could be attained only through extraordinary assistance from the Allied powers.

Since the United States would receive the vast majority of its modern war materials from France, the AEF would be assembled and learn its trade in the heart of France, and the Americans would take their place in the trenches on the eastern part of the Western Front, distant from the British army, it was logical that much of its preparation and training would be in French hands. Where ground warfare was concerned, this logic pretty much held true. When it came to aviation, however, the story was a good bit different. Despite the fact that the Air Service, AEF⁵ ultimately would accept more than 4,800 aircraft from the French and less than 300 from the British and despite the establishment of aviation instruction centers throughout France, the US Army turned to the Royal Flying Corps (RFC)⁶ in its preparations for combat in the air and, in doing so, began a tradition of mutual cooperation between the Royal Air Force and the US Air Force that has endured on many fields of conflict.⁷

The British phased system of flight instruction and RFC stress on disciplined air tactics appealed more than the French *Roleur* system and emphasis on individual flying, though both systems were used.

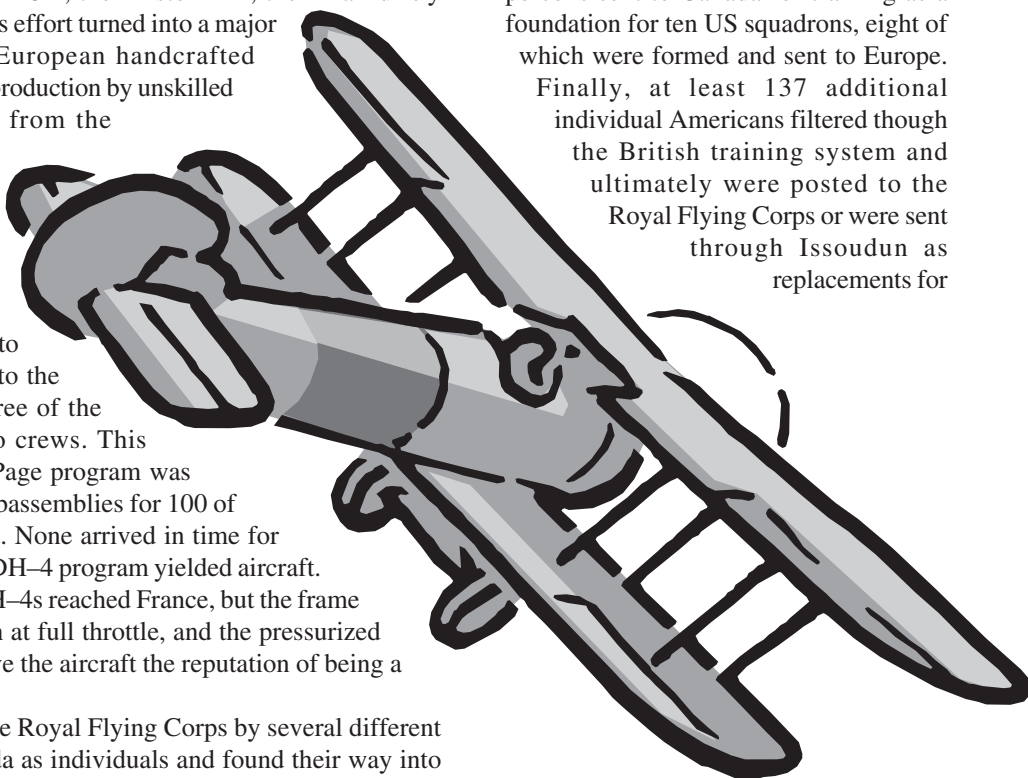
Several reasons underlay this development. Most important, undoubtedly, was the common language and heritage. The close presence of Canada and the role it played in the RFC training program offers another reason. Still another was the compatibility of British methods. One suspects, for example, that the British phased system of flight instruction and RFC stress on disciplined air tactics appealed more than the French *Roleur* system and emphasis on individual flying, though both systems were used. And one also must remember the affinity that quickly developed during the war among British air leaders like David Henderson, Lord Tiverton, and Sir Hugh Trenchard with Air Service leaders like Benjamin D. Foulois, Mason Patrick, and Henry H. Arnold, not to mention a persistent gadfly, who haunted higher military circles, named William “Billy” Mitchell.⁸

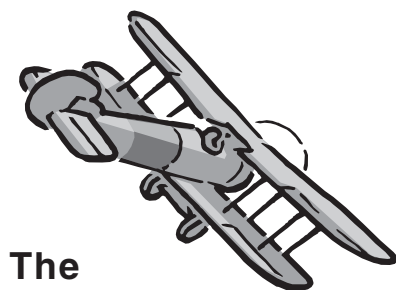
The story of US combat aircraft production is well-known. The Bolling Mission⁹ identified British aircraft for production in the United States with a couple of exceptions, notably the Italian Caproni bomber and French SPAD pursuit. Among the British aircraft selected were the Royal Aircraft Factory SE-5A, the Bristol F2B, the Handley Page O/400, and the De Havilland DH-4. This effort turned into a major fiasco, however. Differences between European handcrafted manufacturing and American assembly line production by unskilled labor hampered the American program from the beginning. The SE-5 program, for example, was complicated by the arrival of an incomplete sample aircraft from England, along with plans and drawings that mixed parts from three different versions of the aircraft. Only one was completed before the program was canceled. Likewise, the effort to stuff the massive 400 hp Liberty engine into the frame of the Bristol fighter failed, and three of the overpowered aircraft crashed, killing two crews. This program was also canceled. The Handley-Page program was only a bit more successful, and complete subassemblies for 100 of the huge bombers were shipped to England. None arrived in time for assembly and operational service. Only the DH-4 program yielded aircraft. Ultimately, some 1,440 Liberty-powered DH-4s reached France, but the frame was too weak to allow the Liberty to be run at full throttle, and the pressurized fuel tank between the pilot and observer gave the aircraft the reputation of being a *flamer*.¹⁰

In the case of pilots, Americans joined the Royal Flying Corps by several different routes. Many crossed the border into Canada as individuals and found their way into

the Royal Flying Corps, which was willing to turn a blind eye to the citizenship of suitable volunteers. More than 300 airmen entered the Royal Flying Corps through this route. Another group of Americans comprised the Oxford Group of 204 Air Service cadets sent overseas in August and September 1917. Originally destined for Italy, they were diverted to the ground school at Oxford University, went through the RFC flying training program, and joined British squadrons on the Western Front. Third, the Toronto Group included 300 cadets and 800 enlisted persons sent to Canada for training as a foundation for ten US squadrons, eight of which were formed and sent to Europe.

Finally, at least 137 additional individual Americans filtered through the British training system and ultimately were posted to the Royal Flying Corps or were sent through Issoudun as replacements for





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Air Service units. Ultimately, somewhere between 900 and 1,100 US citizens flew for the Royal Flying Corps, filling a huge gap in British ranks, before most transferred to the Air Service, AEF, bringing much-needed experience.¹¹

The Air Service, AEF basic doctrine and operational practices were taken mostly from the Royal Flying Corps. Billy Mitchell, in France as an air observer when the United States declared war, spent several days with Trenchard, RFC Commander, touring British facilities, observing operations, and absorbing Trenchard's deep commitment to offensive operations as the bedrock of air. Subsequently, Mitchell contributed to these attributes during the St Mihiel offensive from 12 to 16 September, during which he amassed more than 1,481 Allied and US aircraft and hurled them like a mailed fist against the enemy.¹² Mitchell's stress on concentrating his air assets had a permanent impact on Air Service doctrine. In historian Tami Davis Biddle's words, "His views, reinforced by the apparent success of the autumn campaigns, would establish the principle of concentration as aerial dogma in the United States."¹³ This dogma, combined with Trenchard's emphasis on the offensive, became a trademark of the American way of air warfare.

The British also guided Air Service concepts of strategic bombardment. In November 1917, Major Edgar S. Gorrell presented the new Air Service, AEF, Commander, General Foulis,¹⁴ with a plan for bombing Germany, the main body of which was an almost verbatim copy of Tiverton's 3 September 1917 plan for long-range bombing. And later, Gorrell produced an essay, "The Future Role of American Bombardment Aviation," which included segments of Trenchard's paper on "Long-Distance Bombing" written in November 1917.¹⁵ The two British papers contributed significantly to the doctrine of high-altitude, daylight bombardment of military and industrial targets that characterized US Army Air Forces operations during World War II and US Air Force doctrinal thinking today.

These are just a few examples of the impact of the close relationship between the veteran Royal Flying Corps and neophyte Air Service during World War I. Another example can be seen in the development of *maintenance* training or, what we would call today, *technical* training for enlisted personnel, which, mundane as the subject seems on the surface, is an absolute necessity in the establishment of a modern, professional air force. The Air Service maintenance training effort during World War I, however, began late, and its evolution was chaotic at best before a reasonably defined program began to emerge toward the end of the war. We need to examine this chaos a bit.

To gain an understanding of this development, one must be aware of a significant point. During World War I, the US Army essentially built two separate and different air forces—the first, a training air force in the continental United States; the second, a combination training and combat air force in Europe. A comparison of the chaotic development of maintenance training by the Air Service in the United States with the more logical development of maintenance training by the Air Service, AEF in France—though it was still something less than a smooth process—indicates the importance of the Royal Flying Corps and Air Service, AEF relationship to US combat capability.

It says a lot that the United States declared war on 1 April 1917, received the Ribot cable¹⁶ from France on 24 May 24, and passed a bill authorizing \$640M for aviation on 14 July but that the Air Service did not get around to addressing the need for a formal maintenance training program until October. Until then, the Air Service largely *winged it* where training was concerned. During the first months of the war, it managed to identify and secure a reasonable number of men who either had—or at least claimed to have—some experience with machinery and some mechanical expertise. These men formed the backbone of the early aero squadrons and enabled army aviation to expand. Tested and classified according to their experience and aptitude, *trade tested* in the vernacular of the day, these men learned on the job and enabled army aviation to expand

rapidly without developing formal training for mechanics and technicians.¹⁷

While many of the enlisted men had mechanical experience and could learn on the job from the few experienced personnel available, this approach was not economical at best and useless at worst, as large numbers of inexperienced people entered the service. And it was apparent that even the most knowledgeable mechanics needed training on the peculiarities of aviation engines and airframes. Some knowledge and skill was transferable from civilian jobs, and experienced men could adapt easily. Automobile engine mechanics, for example, could learn aero engines without great difficulty, and wood workers would have little trouble working with airframes. Greater problems were posed by specialists such as sheet metal workers, welders, and tinsmiths who were in short supply. Finally, individuals experienced with skills peculiar to aviation, such as propeller makers, were extremely rare, and drafting the few available would hamper aircraft production. Everything pointed toward the need for an extensive technical training program, but this took time to develop.

Mechanics who made up the earliest squadrons mostly learned through on-the-job training at the various flying fields. Such instruction, however, tended to be haphazard and superficial, especially since, thanks to the shortage of construction troops, most of the early squadron personnel also had to construct barracks, hangars, administrative buildings, and other airfield infrastructure in addition to accomplishing other duties. The Air Service did its best, even publishing in August 1917 a training manual that prescribed a 10-week, on-the-job course of practical instruction in electricity, airplanes, gasoline engines, office work, and telegraphy.¹⁸ This attempt to standardize had merit, but ad hoc, on-the-job training programs were not going to meet expanding Army aviation requirements.

In October 1917, the Air Service turned to private industry for assistance, asking a number of civilian factories to admit enlisted personnel and train them in several specialties where severe shortages existed. This approach had a number of advantages. Enlisted personnel would get extensive training from experienced civilian technicians, while the factories would benefit from the influx, even if temporary, of trainable, largely enthusiastic workers who did not have to be paid by the company. The first 25 enlisted men joined an oxyacetylene company on 11 November 1917 for a 3-week course on welding. By the end of the

Roger G. Miller, PhD

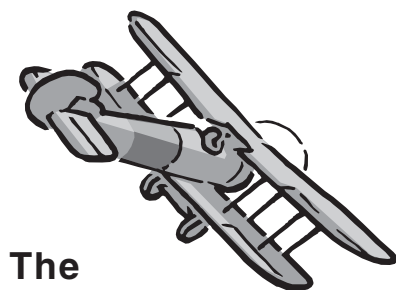


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Technical Training Center, Denver, Colorado; Headquarters Air Training Command, Randolph AFB, Texas; Headquarters Seventeenth Air Force, Sembach AB, Federal Republic of Germany; and Headquarters US Air Force in the Pentagon. He joined the book-writing program in the Center for Air Force History in January 1993. Among his responsibilities, Dr Miller writes, publishes, and lectures widely on many aspects of airpower history. His primary areas of interest include air logistics, air transportation, and early military aviation history.

Dr Miller's most recent book, *To Save a City: The Berlin Airlift, 1948-1949*, was published by Texas A&M University Press in November 2000, and his articles and reviews have appeared in the *Journal of American History*, *Indiana Magazine of History*, *Military History*, *Air Power History*, *The Public Historian*, *Prologue*, *The Journal of Air Force Logistics*, and *Camaraderie*. His most recent contributions to the Office of Air Force History monograph series include *A Preliminary to War: The 1st Aero Squadron and the Mexican Punitive Expedition of 1916* and *Billy Mitchell: Stormy Petrel of the Air*, both published in 2004. Dr Miller is currently writing a full-length biography of World War II air leader Lieutenant General Lewis Hyde Brereton.



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month, an additional 300 or more men had entered companies where they learned 14 different technical specialties. Pleased with the success of the initial courses, the Air Service extended the program on 15 January to the aircraft, aviation engine, and tire industries. In all, more than 30 companies eventually took part in this program, training more than 2,000 mechanics and specialists.¹⁹

About the same time, winter closed the flying training programs at Chanute, Hazelhurst, Scott, Selfridge, and Wilbur Wright Fields. On 1 November 1917, Air Service officials decided to use these facilities for technical instruction. The Air Service advertised for experienced personnel from industry for instructors. Seventeen applicants became officers, 48 received enlisted rank, and 5 became aviator *mechanicians*. They then received 3 weeks of military training at Selfridge Field. The five schools opened on 1 January 1918 with about 315 students, but some slippage took place between plans and performance. From the first, the five schools were hampered by a shortage of instructors and equipment, the severe winter weather, and a measles epidemic. By the time they ceased operation on 1 April 1918, however, these fields had produced 574 engine and 1,120 airplane mechanics, 939 motor transport specialists, and 30 welders.²⁰

In December 1917, Air Service planners explored the expansion of maintenance and specialist training through civilian vocational schools. A detachment of enlisted students arrived at the Dunwoody Industrial Institute in St Paul, Minnesota, on 10 December. The initial courses proved excellent, and on 1 January 1918, the Liberty Engine Ignition School opened under the supervision of five of Dunwoody Institute's best instructors. Subsequently, the Institute taught courses that ranged from aircraft and motor maintenance to instrument repair. Additional courses opened at the Carnegie Institute of Technology in Washington DC on 25 January for coppersmiths, blacksmiths, and motor and aircraft repairmen; at the Pratt Industries, in Brooklyn, New York, on 18 March for carpenters, cabinetmakers, and motor mechanics; and at the David Rankin School of Mechanical Arts in St Louis on 1 March for carpenters, blacksmiths, electricians, metal workers, propeller specialists, and motor mechanics. The use of vocational schools proved highly successful, and the Air Service soon incorporated the training at St Paul as a permanent part of its wartime technical training program.²¹

Finally, in mid-November, the Air Service established the Enlisted Mechanics Training Department at Kelly Field near San Antonio, Texas. Initially, this effort bordered on farce. Kelly authorities designed a program for 320 men and set it up in eight hangar tents, each with an aircraft, engine, and instructor. Three days later, a Texas *norther* blew everything down. The officials immediately reestablished the program in two metal hangars, but then no students came. The Kelly Field commander appealed to the commander of the US Army's Southern Department, who ordered every squadron forming at Kelly to furnish a cadre of trainees. The squadrons immediately furnished 3,000 men who, first, were not the best men in each unit and, second, completely overwhelmed the program with their numbers. Directed to return to their units, the men responded by stripping the engines and airplanes of parts as souvenirs of the experience. Unsurprisingly, on 29 December, Army inspectors closed down the program. Opened again in January 1918, the school still proved unsatisfactory. Kelly officials then revised the curriculum, provided increased quantities of training equipment and reference materials, put the instructors through an extensive training course, and reopened the program once again on 18 March. The revised program was successful, and by 30 June 1918, it had graduated 419 airplane and 300 motor mechanics, as well as 195 motor transport specialists. These men ultimately were rated as some of the best technical personnel sent to the flying squadrons in the United States and in France. Subsequently, the Air Service expanded the program to a capacity of 1,000 students. Renamed the Air Service Mechanics School, it became the foundation for the technical training system operated by today's Air Force.²²

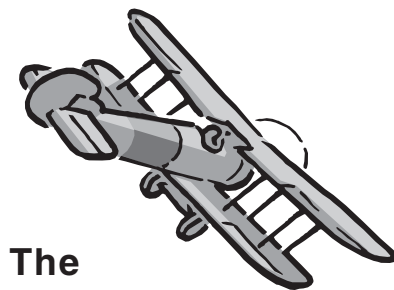
It is important to note that the men who went through these programs received general rather than system-specific training. In the case of engine mechanics, for example, they trained to work on *an* aero engine, not necessarily *the* aero engine that they would find when they reached the flight line. This was less true for mechanics assigned to flying fields in the United States, who usually received instruction on the ubiquitous Curtiss and Hall-Scott engines, especially after these became available in large numbers in early 1918. But many mechanics who had never touched anything but a Curtiss OX-5 suddenly found themselves confronting the mysteries of the geared Hispano-Suiza V-eight, the water-cooled radial Salmson, or the air-cooled Gnome and Le Rhône rotaries, in which the entire engine spun around its own crankshaft. These men still had to learn on the job, adapting their general knowledge to the peculiarities of whatever equipment their unit operated. In the last few months of the war, however, the Air Service addressed this deficiency by establishing specialized schools at various factories where engines were being built, including the Liberty Motor School in Detroit, Michigan; the Hispano-Suiza School at New Brunswick, New Jersey; and the Le Rhône Engine Course at Swissvale, Pennsylvania. System-specific instruction also took place in the Ignition Course at the Splittorf Magneto Plant at Newark, New Jersey; the Instrument Course taught at Langley Field, Virginia; and the Handley-Page School at the Standard Aircraft Corporation in Elizabeth City, New Jersey.²³

In summary, by June 1918, the various approaches to maintenance and specialist training had succeeded in meeting the Army's most serious requirements in the United States and in France, enabling the Air Service to concentrate the body of its formal technical training programs at the Air Service Mechanics School at Kelly Field and the Dunwoody Industrial Institute. These programs functioned until the end of the war. Altogether, the different programs graduated 14,176 enlisted mechanics and technical persons by 11 November 1918.²⁴

Now, where does the Royal Flying Corps come into all this? The Air Service made an early effort to establish its own maintenance training program in France; however, this approach quickly fell apart because of a lack of facilities, training equipment, and instructors. Thus, what training initially took place in Europe was on-the-job at the various flying fields and repair centers, and the Air Service turned to France and England to fill the mechanics training gap. The French Government proved much less helpful in this regard than in other areas. At the request of the French, in 1917, the Air Service, AEF ordered some 475 enlisted persons to French flying fields for instruction, while another 200 aero mechanics were sent to work in French aircraft factories where they received practical experience, if not formal training. These men served in the factories until Foulois requested their return in January 1918. But this was just a drop in the bucket compared to the number required—and the number trained with British assistance.²⁵

Help from Great Britain began in the United States when the Air Service took advantage of a training program already in existence. In July 1917, Colonel Cuthbert G. Hoare, commander of the Royal Flying Corps in Canada, proposed a reciprocal training program in which the Royal Flying Corps would train ten American squadrons in Canada in exchange for the use of three flying fields in the United States for winter training when weather closed many of the fields in Canada. The Air Service accepted the offer and built three fields at Camp Taliaferro near Fort Worth, Texas. Subsequently, Hoare offered to train an additional eight squadrons in exchange for extended use of these fields. Eight of the first ten squadrons trained under this program saw operational service in France; however, the process was hardly as straightforward as it seemed on the surface. Ultimately, the Canadian program trained some 4,800 American pilots, ground officers, and enlisted persons. It was a successful program but answered only a part of the need for trained mechanics.²⁶

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The concept of swapping training in exchange for warm bodies lay at the bottom of the most extensive training program established overseas during the war. Major Raynal C. Bolling had discussed training American mechanics with British authorities while the Bolling Commission was in England in June 1917, and in September, shortly after the first American air units reached France, several detachments in transit to France were diverted to England for instruction on British aircraft. These included the 34th Aero Squadron and 50-man detachments from seven other squadrons. These were joined in October by five additional flying squadrons and several construction units. Subsequently, negotiations between Pershing and the British Air Ministry led to the Mechanic Training Agreement signed on 5 December 1917. This agreement provided that the Air Service would send 15,000 mechanics to England by 1 March 1918 for training by the Royal Flying Corps. Their presence would release a corresponding number of British mechanics for service at the Front. When trained, the American mechanics would be released to the Air Service, AEF in France at the same rate that they were replaced in England by new trainees from the United States. The agreement also called on the Air Service to furnish 6,200 American construction persons—including carpenters, bricklayers, and laborers—to work on RFC flying fields.²⁷

Shipping problems handicapped the program from the beginning, however, and only 3,931 mechanics had reached England by 1 March 1918, the date by which all 15,000 were supposed to be on hand. Then, the German spring offensive forced Allied and American leaders to revise the shipping schedules in favor of ground troops, further delaying the arrival of trainees.²⁸ Shortages of shipping also interrupted the transport of construction personnel. As a result, the planned total of 15,000 men in training was not reached until August. Despite such problems, however, the British mechanics training program made an absolutely vital contribution to the development of the Air Service, AEF capability in France. As of 30 May, the Air Service had 73 flying squadrons, 18 repair squadrons, and 3 supply squadrons, mostly at British flying training fields. Almost all the men in the flying squadrons had some experience with Curtiss JN-4 *Jennies* and their OX-5 engines at American training fields. In England, they gained valuable knowledge on a wide variety of combat engines and airframes similar to those they would service in France.²⁹

An officer who visited 15 training centers in England observed American mechanics doing “every class of skilled work required in connection with an aerodrome.”³⁰ Inspectors who reviewed the program concluded that the Americans were more technical-minded than their British counterparts and had greater enthusiasm and higher morale—hardly surprising given that Britain was in its fourth year of seemingly unending bloodshed. Early shortages of training equipment, facilities, and experienced instructors took time to solve but were overcome. One problem proved impossible to resolve. Americans disliked English food. Most, one could say with some accuracy, would walk a mile for American canned *monkey meat* rather than indulge in English cuisine. And when it came to tea, the word *despised* suggests itself. Then, as now, *kippers* were hardly an American breakfast staple, and the US Army ran on coffee. Of greater significance, however, both British and American officials had a tendency to lose sight of the fact that training was the primary goal of the program. Too many wanted to treat the men as permanent replacements for British mechanics. Additionally, the dispersal of units across England made the program difficult to manage and forced the Air Service to establish an organization to track progress. Adoption of a reasonably standardized 3-month training scheme aided in this effort, as well. In June 1918, the Air Service also developed a standard squadron organization for the units in England, which through the addition or subtraction of 10 percent of its people could be modified into any type of flying squadron required. Still, it might have been more efficient and less disruptive to manage the program by individuals rather than squadrons. Requests could have gone to England by specialty. Officials in London then would have filled

those requests by selecting the best trained personnel from the locations where they could best be spared. These then would be sent to St Maixent in France where the aero squadrons were organized and equipped.³¹

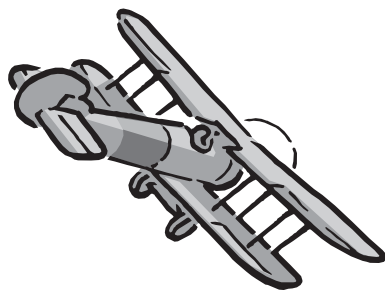
By May 1918, Air Service officials faced a serious shortage of mechanics in France and sought to draw on those in England. British air leaders, however, had become dependent on American manpower and opposed releasing American units until replacements had arrived in accordance with the 5 December 1917 agreement. "I am thoroughly convinced that if tomorrow the majority of American squadrons were to be removed from England," 1st Lieutenant T. P. Walker of the Air Service reported, "the Royal Air Force would be severely crippled, and at certain stations, their training would come to a complete standstill."³² To resolve the problem, General Patrick, new chief of the Air Service, AEF,³³ met with the British air officials in London "and placed our situation clearly before them." Bowing to American needs, the British agreed to release 3,500 mechanics who, Patrick agreed, would be replaced as quickly as replacements from the States became available.³⁴

In June 1918, the first five squadrons—the 49th, 50th, 93^d, 135th, and 213th Aero Squadrons—left England for France. As of 1 July, 72 squadrons were judged trained, and over the next few months, many of these rejoined the Air Service, AEF. All in all, the program provided a huge boost in trained maintenance personnel for the Air Service in France, as well as essential manpower for the Royal Flying Corps. The English program ultimately trained 22,059 men, of which 11,170 were sent to France. At least 18 of the 45 flying squadrons that fought with the Air Service on the Western Front received a major portion of their training in England. Other squadrons manned assembly plants, repair depots, flying fields, and airparks. Of those remaining in England, several were diverted to man the Handley-Page development program described below. Still others were in the personnel pipeline flowing to the Front when the armistice took effect.³⁵

A large number of mechanics remained stuck in England, however, tied up by a program that, had the war lasted into 1919, might have led to an Air Service strategic bombing capability. The Handley-Page program grew out of the American desire to develop its own long-range bomber force. On 26 January 1918, Foulois signed an agreement with the British that provided for the manufacture in the United States of enough twin-engine Handley-Page bombers—powered by Liberty engines and equipped with all weapons, instruments, and accessories—to equip 30 American squadrons. These would be shipped to England in prefabricated pieces and assembled at production plants built especially for that purpose. The program also required shipping American personnel to England to construct the facilities required for the program, as well as providing enough mechanics to be trained to maintain the big airplanes. Final training for the squadrons would take place at several airfields in England.³⁶

Work on the project began immediately. Assembly plants were established in two cotton mills near Oldham, and five airfields were identified as training sites. The Air Service shipped some 3,000 carpenters, bricklayers, and laborers to England to prepare these facilities. Instruction for the flying squadrons began at sites in the United States and continued in England using ten Handley-Page bombers borrowed from the British, powered by Liberty engines loaned by the US Navy. Unfortunately, as already noted, the project came to naught. First, the same kind of design and fabrication problems that delayed production of the De Havilland DH-4 and other aircraft afflicted the Handley-Page program. The big bomber comprised more than 100,000 parts, and construction was parceled out to several companies. But American industry proved incapable of making such a system function, and production quickly fell months behind schedule. By November 1918, only about 95 percent of the parts for 100 aircraft and less than 50 engines had

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Deficiencies in their organization, the process of sending thousands of airmen to Europe for training, and the need for all pilots to receive flying training after they reached Europe had fragmented the squadron mobilization process.

reached England. Second, less than 60 percent of the production and assembly personnel reached England. Finally, bad weather, conflict with British trade unions, and frequent strikes delayed construction of the assembly facilities.³⁷ The one part of the program that worked well, unfortunately, was the shipping of several thousand potential mechanics to England for training. There they remained, waiting for aircraft that never arrived. Colonel Henry H. Arnold, later commander of the US Army Air Forces during World War II, concluded, “The only result [of the Handley-Page program] was that the American air outfits in France were deprived of their needed services.”³⁸

Despite all the training programs in the United States, England, and France, the Air Service never completely got a handle on maintenance personnel. The problem lay in two spheres, the malassignment of trained mechanics and the need to use them to accomplish additional military roles. Colonel Walter C. Kilner, chief of the Training Section for the Air Service, emphasized the deficiencies in trade testing, which was, all too often, done by Army officers with little knowledge of what they were doing. Trade testing, he asserted, should be done by experts in those trades, and he singled out the squadrons formed at Kelly early in the war as examples.

Wood workers were rated as machinists, farmers as mechanics, and good machinists were given fatigue duties. Clerks were made mechanics, and good mechanics were made clerks, and then the entire squadron would be turned over to a supposedly technical officer for further training and assignment to duty. Under such conditions, it is not strange that mechanical work progressed slowly and that much of it was not properly done.³⁹

Captain Charles W. Babcock, chief aeronautical engineer at the Third Aviation Instruction Center at Issoudun, reported that an improper distribution of mechanics plagued his maintenance efforts until the end of the war, and expert mechanics often were unavailable for duty because they were doing kitchen police, guard duty, or other labor.⁴⁰ The problem extended to specialists of all types. In August 1918, newly assigned 2^d Lieutenant R. H. Wessman, armament officer of the 50th Aero Squadron, found his 13 armorers away from their duty stations “doing all kinds of fatigue work.” Then, when he finally mustered his troops, he discovered that only three had any training for their duties.⁴¹ Other units, like the 90th Aero Squadron, fared much better: “Specialized training was necessary,” the unit history later stated about its enlisted men, “but nearly all were by trade expert mechanics, who had volunteered for the work to which they were assigned and who were enthusiastic over the prospect of doing their *bit* along the lines for which they were peculiarly fitted.”⁴²

In July 1918, the Air Service formalized the process for assigning mechanics to the flying squadrons and forming squadrons in France. While most of the earlier squadrons had arrived more or less intact, deficiencies in their organization, the process of sending thousands of airmen to Europe for training, and the need for all pilots to receive flying training after they reached Europe had fragmented the squadron *mobilization* process. On 16 July, Patrick directed that all ground officers and enlisted men arriving in France, especially from the schools in England, would go to the Air Service Replacement Concentration Barracks at St Maixent. At St Maixent, the Air Service established a barracks, storage building, and trade center convenient by railroad to the main AEF base ports. There the new arrivals were trade-tested, given additional instruction, issued the correct personal equipment from the stocks maintained there, and reorganized into units as required. Once prepared, the units were sent temporarily to Orly, Romorantin, or one of the flying training centers. At these locations, squadron personnel augmented the permanent workforce, gaining in the process additional familiarity with their duties. From there, most units moved to the 1st Air Depot at Colombey-les-Belles where they met their new commanding officer, received contingents of Ordnance and Medical Department personnel, and secured all required squadron equipment and transportation. Airplane and motor spares were divided into squadron lots, park lots, and reserve lots, and shipped to the 1st Air Depot where they were issued to the squadrons and airparks

as appropriate. A second reserve lot was sent to the Air Service, AEF spares depot. Pilots came from Issoudun and aircraft from the depots, acceptance field, or production center. The fully equipped squadrons were then directed to their front-line destination as complete units. As of 10 August 1918, the Coordination Section at Air Service Headquarters managed all aspects of this process. Section personnel knew at all times where each element was that made up a particular squadron, enabling them to anticipate requirements at each stage of the mobilization process, monitor developments, and massage any problems. The Air Service now had the ability to send squadrons to the Front according to a preplanned schedule rather than haphazardly as before.⁴³

In summary, starting from almost nothing in April 1917, the United States had developed a modern, by contemporary standards, air force capable of providing minimum support to the field army operating on the Western Front. Within the United States, as has been discussed, the Air Service operated a training air force that provided itself with instructor pilots and the AEF in France pilots with basic flying skills. One part of the original program was never completed: the failure of American industry to produce suitable aircraft prevented establishing a complete training program at home and shifted the main burden of advanced flying training to France. The buildup of the Air Service in Europe had begun slowly but accelerated dramatically during the last 4 months of the war. The final numbers cannot be reconciled totally with confidence, but as of the last day of the war, the Air Service in France had received 6,364 aircraft: 19 from Italy, 258 from England, 4,874 from France, and 1,213 from the United States.⁴⁴ Some 2,698 service aircraft had been sent to the Zone of Advance, while 714 service aircraft remained at the main depots and acceptance parks. Of those sent to the Zone of Advance, the operational flying squadrons had received 2,495 aircraft, while 203 remained in the advance air depots. Attrition had been high, and 1,627 service aircraft had been lost through accident or combat.⁴⁵

At the armistice, the 45 squadrons of the Air Service, AEF at the Front were capable of providing reasonable reconnaissance and bombing support for the ground troops and aerial defense for itself. On the other hand, the size and strength of the AEF at that time actually justified a much larger air force, more than 100 squadrons. Further, the 45 squadrons at the Front were terribly under strength, fielding only 457 operational aircraft out of an authorization for more than 700.⁴⁶ In part, this was a result of the heavy losses during the Meuse Argonne fighting. In part, it resulted from difficulties with the type of equipment available like, for example, the complex and delicate, Hispano-Suiza-gear 220 hp engine that powered the Spad XIII. In part, it reflected a shortage of replacement aircraft, spares, and parts from the hardpressed French. But in part, it also was a result of the weaknesses in the maintenance training program that had taken so long to develop. World War I, in short, presented the US Air Service and its successor organizations with mixed results. Thanks to the assistance from the European allies, especially the Royal Flying Corps, it had come an incredibly long distance in an extremely short time. Yet, at the armistice, many weaknesses remained, and much more needed to be accomplished. Perhaps, it is most accurate to say in summary that a foundation for the future had been established, but little more.

Notes

1. Quoted in Edward M. Coffman, *The War to End All Wars: The American Military Experience in World War I*, The University of Wisconsin Press, 1986, 11. Coffman remains, perhaps, the best single-volume study of the US experience during World War I.
2. On amalgamation, see Coffman, 9-10.
3. Quoted in John J. Pershing, *My Experiences in the World War*, 2 vols, New York: Frederick A. Stokes Company, 1931, I, 38

Within the United States, as has been discussed, the Air Service operated a training air force that provided itself with instructor pilots and the AEF in France pilots with basic flying skills.

4. The standard biographies of Pershing are Donald Smythe, *Guerrilla Warrior: The Early Life of John J. Pershing*, New York: Charles Scribner's Sons, 1973, and Donald Smythe, *Pershing: General of the Armies*, Bloomington: Indiana University Press, 1986.
5. For clarity, the term Air Service in this article refers to the military aviation establishment in the continental United States, and the term Air Service, AEF refers to that in Europe. The distinction is indicative of the division in US military aviation at the time. Military aviation in the United States began under the Aeronautical Division of the Signal Corps and remained under that branch of the service until 1918, although the name of the office changed several times. On 20 May 1918, aviation was separated from the Signal Corps and embodied in two organizations, the Director of Military Aeronautics and the Aircraft Production Board. These two, known already as the Air Service, finally were combined into a single organization on 27 Aug 18. In contrast, Pershing separated aviation from the Signal Corps in the AEF in July 1917. The establishment in France, thus, became the Air Service, AEF and continued under that name throughout the war.
6. Again, for clarity, the Royal Flying Corps became the Royal Air Force on 1 Apr18, but this article will use RFC throughout. RAF will be used to refer to the service after the war.
7. John H. Morrow, Jr, *The Great War in the Air: Military Aviation from 1909 to 1921*, Washington DC: Smithsonian Institution Press, 1993, 338. See also Lee Kennett, *The First Air War, 1914-1918*, New York: The Free Press, 1991. On the US Air Service during World War I, see Arthur Sweetser, *The American Air Service: A Record Its Problems, Its Difficulties, Its Failings, and Its Achievements*, New York: D. Appleton, 1919; Lt Lucien H. Thayer; *The Official History of the US Air Service, AEF (1917-1918)*, ed by Donald J. McGee and Roger J. Bender, San Jose, California: R. James Bender Publishing, 1983; James J. Cooke, *The US Air Service in the Great War*, Westport, Connecticut: Praeger, 1996.
8. Rebecca Hancock Grant, *Training to Fly: Military Flight Training, 1907-1945*, Washington DC: Air Force History and Museum Program, 1999, 101-99, describes the development of Air Service flight training programs during World War I.
9. Maj. Raynal C. Bolling, former counsel for the US Steel Corporation, led a team of military and industrial experts to Europe in June 1917 to determine the best equipment and materiel to be produced in the United States.
10. Morrow, 268-71, 321, 340-43. For extensive examination of US manufacturing failures, especially in aviation, see, Benedict Crowell, *America's Munitions, 1917-1918*, Washington DC: Government Printing Office, 1919, and I. B. Holley, Jr, *Ideas and Weapons: Exploitation of the Aerial Weapon by the United States; A Study in the Relationship of Technological Advance, Military Doctrine, and the Development of Weapons*, New Imprint, Washington DC: Office of Air Force History, 1983.
11. James J. Sloan, Jr, *Wings of Honor: American Airmen in World War I*, Atglen, Pennsylvania: Schiffer Military/Aviation History, 1994, 104-107.
12. Morrow, 336, 337. Mitchell's activities during the St Mihiel offensive are detailed in James J. Cooke, *Billy Mitchell*, Boulder, Colorado: Lynne Rienner Publishers, 2002, 84-94.
13. Tami Davis Biddle, *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas About Strategic Bombing, 1914-1945*, Princeton, New Jersey: Princeton University Press, 2002, 53.
14. Brig Gen Benjamin D. Foulois, one of the US Army's earliest aviators, replaced Brig Gen William Kenly as chief of the Air Service, AEF on 27 Nov 17.
15. Biddle, 53-56.
16. Alexandre Ribot was the French premier. His cable called for the United States to produce 4,500 planes, 5,000 pilots, and 50,000 mechanics and became the basis for early Air Service planning.
17. Hiram Bingham, *An Explorer in the Air Service*, New Haven: Yale University Press, 1920, 59-60; Sweetser, 140-41.
18. Royal D. Frey, "Evolution of Maintenance Engineering, 1907-1920," Historical Study No 327, Historical Division, Air Materiel Command, Jul 60, 83.
19. Frey, 86-87.
20. Sweetser, 143-44; Lt F. J. Pendergrast, "History of the Air Depot at Fairfield, Ohio, 1917-1943," 6-7, Microfilm Reel A2107, Frames 186-626, Air Force Historical Research Agency (AFHRA), Maxwell AFB, Alabama.
21. Frey, 88-89.

22. Henry H. Arnold, "Aviation Section, Signal Corps, and Division of Military Aeronautics, April 1917-October 1918," nd, 10, 168.65011-4, Ernest L. Jones Collection, AFHRA; Sweetser, 144; Frey, 85-86.
23. Frey, 106.
24. Frey, 89-90.
25. Maj Gen Mason M. Patrick, "Final Report of the Chief of the Air Service, AEF," in Maurer Maurer, ed, *The US Air Service in World War I*, 4 vols, Washington, DC: Office of Air Force History, 1978, I, 55, 58-59; Memo, Maj Birdseye B. Lewis, Materiel Division, Air Service, AEF, to ACA, 25 Sep 17, atch to Supply Section Questionnaire, 4 Jan 19, Box 4, the papers of Col Halsey Dunwoody, AFHRA.
26. Arnold, "Aviation Section, Signal Corps, and Division of Military Aeronautics," 5-6; Frey, 87; S. F. Wise, *Canadian Airmen and the First World War*, Vol 1, The Official History of the Royal Canadian Air Force, Toronto: The University of Toronto Press, 1980, 91-97.
27. Rpt No 6, Maj Raynal C. Bolling to Chief Signal Officer, subj: Conference Between American Representatives and Subcommittees of the Air Board, 29 Jun 17, Box 4, Dunwoody Papers, AFHRA; Patrick, "Final Report of the Chief of the Air Service, AEF," 59; Thayer, 249-50. Pershing's cable announcing the program may be found in Lt Col G. M. Murphy, General Staff, AEF, "Recapitulation of United States Air Service Work in Great Britain & Ireland," nd, Series A, Vol 16, Roll #4, "Col Gorrell's History of the US Army Air Service," Microcopy, T-619, The National Archives, Washington DC.
28. This operation, code named Kaiserschlacht, erupted on 21 Mar 18 and, for a time, threatened to rupture the entire Allied front. The emergency led Pershing to agree to transport riflemen by ship from the United States in large numbers rather than complete, balanced infantry divisions. Less room remained for personnel from other organizations like the Air Service, AEF, as well.
29. Thayer, 251.
30. Memo, 1st Lt T. Walker, to chief of Personnel, Air Service, AEF, subj: American Squadron Training in England, nd, Series A, Vol 15, Roll #4, Gorrell.
31. Walker; Frey, 137-44, 168.
32. Walker.
33. Maj Gen Mason M. Patrick, an engineer and nonflyer, replaced Foulois as Chief of the Air Service, AEF on 29 May 18. He served in that capacity through the armistice.
34. Maj Gen Mason M. Patrick, *The United States in the Air*, Garden City, New York: Doubleday, Doran and Company, 1928, 19-20.
35. Thayer, 252-53; Frey, 146.
36. Crowell, 261-62; Thayer, 37.
37. Rpt, Capt N. W. Owens, Adj, Night Bombardment Section, to Aviation Officer, BS No 2, SOS, AEF, subj: Handley-Page Operations in England, 16 Jan 19, Series A, Vol 15, Roll #4, Gorrell; Thayer, 253-54.
38. Henry H. Arnold, *Global Mission*, New York: Harper & Brothers, 1949, 71.
39. Col Walter C. Kilner, Chief, Training Section, in Maurer, *US Air Service*, IV, 328.
40. Capt Charles W. Babcock, Chief, Aeronautical Engineer, Third Aviation Instruction Center, in Maurer, *US Air Service*, IV, 244.
41. 2^d Lt R. H. Wessman, armor officer, 50th Aero Squadron, in Maurer, *US Air Service*, IV, 234.
42. Leland M. Carver, Gustav A. Lindstrom, and A. T. Foster, *The Ninetieth Aero Squadron, American Expeditionary Forces*, Hinsdale, Illinois: E. Harold Griest, 1920, 10.
43. Supply Section Questionnaire, 4 Jan 19, 28, Box 4, Dunwoody Papers, AFHRA; Maj Gen Mason M. Patrick, "Final Report of the Chief of the Air Service, AEF," in Maurer, *US Air Service*, I, 73, 78; Toulmin, *Air Service, AEF*, 130-32, 234; Air Service Memo No 22, 16 Jul 18, and Memo No 44, 10 Aug 18, which set up the squadron mobilization process are reprinted in Toulmin, 118-22, 125-27.
44. "Statistics with Relation to Supply as of 11 Nov 18," Box 3, Dunwoody Papers, AFHRA.
45. Col Halsey Dunwoody, Chief of Supply, Air Service, AEF, subj: Complete Record of Service and Training Planes Delivered by Supply Section, Air Service, to Air Service Troops and Schools in France and England from the beginning of operations to 10 Nov 18, nd, in "Notes on Supply," Book I, Box 3, Dunwoody Papers, AFHRA.
46. Morrow, 338.





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A part grouping system, however, effectively leverages a supply chain by arranging the production of individual items into groups that are based on common manufacturing processes.

Part Grouping

Angioplasty for the Supply Chain

Hey, *loggie* warfighter, your aged weapon systems are full of *tired iron*, you have diminishing manufacturing sources for mission critical spare parts, your industrial base is getting colder, and lead times are getting longer each day.

Agile Combat Support

Logistically, you have hardening of the arteries.



Colonel Michael C. Yusi, USAF

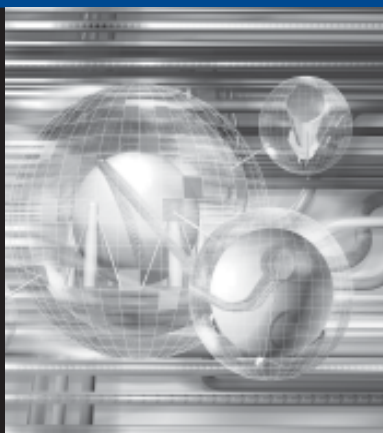
The Editorial Advisory Board selected "Part Grouping"—written by Colonel Michael C. Yusi, USAF, Vol XXVII, No 1—as the most significant article to appear in the *Air Force Journal of Logistics* in 2003.

The Japanese were not the first to ignore the importance and vulnerability of logistics.

Oil Logistics In the Pacific War

Lieutenant Colonel
Patrick H. Donovan, USAF

As long ago as 1187, history shows that logistics played a key part in the Muslim's victory over the Crusaders at the Battle of Hittin. The Muslim commander Saladin captured the only water source on the battlefield and denied its use to the Crusaders.



The Editorial Advisory Board selected "Oil Logistics in the Pacific War"—written by Lieutenant Colonel Patrick H. Donovan, USAF—as the most significant article to appear in Vol XXVIII, No 1 of the *Air Force Journal of Logistics*.

Lieutenant Colonel Joseph E. Diana, USAF

Improving Bare-Base Agile Combat Support

A Comparative Analysis Between Land Basing and Afloat Prepositioning of Bare-Base Support Equipment

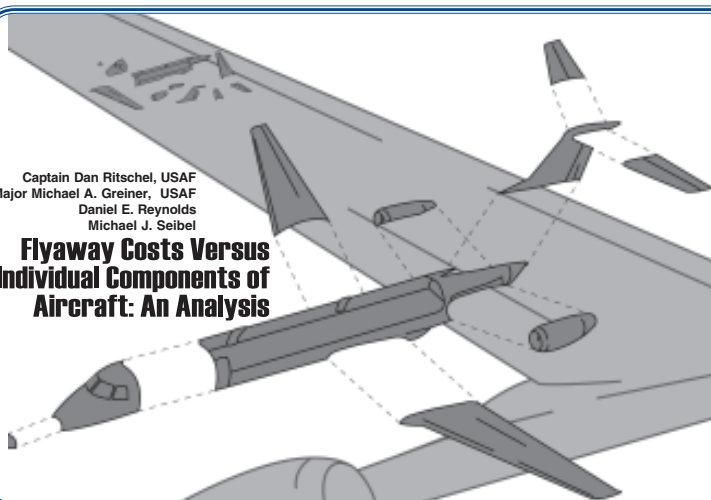
To improve Air Force agility in establishing bare-base operations, RAND and the Air Force Logistics Management Agency analyzed current conditions separately and recommended potential solutions.



The Editorial Advisory Board selected "Improving Bare-Base Agile Combat Support: A Comparative Analysis Between Land Basing and Afloat Prepositioning of Bare-Base Support Equipment"—written by Lieutenant Colonel Joseph E. Diana, USAF—as the most significant article to appear in Vol XXVIII, No 2 of the *Air Force Journal of Logistics*.

Captain Dan Ritschel, USAF
Major Michael A. Greiner, USAF
Daniel E. Reynolds
Michael J. Seibel

Flyaway Costs Versus Individual Components of Aircraft: An Analysis



The staff of the *Air Force Journal of Logistics* selected "Flyaway Costs Versus Individual Components of Aircraft: An Analysis"—written by Captain Dan Ritschel, USAF; Major Michael A. Greiner, USAF; Daniel E. Reynolds, and Michael J. Seibel, Vol XXVII, No 4—as the best article written by a junior officer to appear in the *Air Force Journal of Logistics* in 2003.